University of Nevada, Reno

Teaching Young Children Science: Early Care and Education Teachers' Attitudes, Beliefs, and Classroom Practices

A thesis submitted in partial fulfillment of the
requirements for the degree of Master of Science in
Human Development and Family Studies

by

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August 2020

THE GRADUATE SCHOOL

We recommend that the thesis
prepared under our supervision by

entitled

be accepted in partial fulfillment of the
requirements for the degree of

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Abstract

Despite the importance of science learning for young children, many teachers may not have favorable attitudes and beliefs towards teachings science, which may reflect on their science-related classroom practices. The current study consisted of early care and education teachers (*N* = 110) of children aged 2- to 5 years old from a northwestern metropolitan area of the U.S. With an online survey, the study investigated relationships between the early care and education teachers' attitudes and beliefs toward teaching science to young children, their science-related practices in the classroom, and their professional and program characteristics. Positive relationships exist between teachers' attitudes and beliefs toward teaching science and their classroom practices. Positive relationships were found between teachers' professional characteristics, attitudes and beliefs toward teaching science, and classroom practices. Results indicated that greater educational attainment and science-specific professional development were related to higher scores of attitudes and beliefs and classroom practices. Teachers in public programs reported higher scores on child benefit and classroom practices than those in private programs. Implications for future direction are presented including providing early care and education teachers with science-specific professional development and science-related teaching interventions to improve teachers' science-content knowledge and teaching confidence.

Keywords: early care and education, early childhood science education, attitudes, beliefs, self-efficacy, classroom practices

Dedication

I dedicate this thesis to my husband and children who have persevered through thick and thin. I could not have done this without all of your unconditional love and unceasing support. My dear husband, Trenton, you for better and for worse, stood by my side and with continued reassurance and encouragement, plenty of mental reinforcement, and undying conviction in my ability to complete this journey. Treading through these thesis years, the journey has been potholed, sometimes downright tedious and heavy, with little direction on how to raise a family and keep my feet moving forward. You met me in the middle to help us balance raising this beautiful family and still pursue this dream. At times you took on all the responsibilities so that I could get through what seemed like endless evenings of reading, studying, and writing. To my children, Trevor, Joliette, Addison, and Caedon, I thank you for your laughter and humor, your adventurous spirits, and your willingness to help Dad out when I was buried in thesis. I truly couldn't have done this without you nor would I want to. You inspire me to be the best mom and student that I can be so that you will be assured of your own triumph one day, whatever and wherever that is. This has been the most momentous learning experience that I could have imagined. I'm proud to have had you all on my side.

Acknowledgements

I would like to convey my sincerest gratitude to Dr. Hyun-Joo Jeon for your outpouring of encouragement and steadfast support throughout my educational and thesis journey. Your knowledge has been indispensable but your wisdom throughout this process has been priceless, which without I would not be here. You readily embraced my thirst for research and taught me volumes about the process that could not be taught in a classroom. You provided me opportunity to work with your research team which has provided me the potential to follow the research process from beginning to end. You have helped me to overcome barriers in small leaps through encouraging research presentations at the university and national conferences. Thank you for your belief in me, your mentorship, and friendship.

I would also like to express my deepest appreciation to the members of my committee for their willingness to serve on my committee and especially for forfeiting several of their summer hours to read my thesis and meet with me. Your feedback has been instrumental in the progress of this thesis. Dr. Jen Mortensen, it has been a joy to work alongside you. I always enjoyed your excitement for teaching and learning about early childhood development, which inspired me greatly in furthering my education. Thank you for lending an ear through some pretty tough times and encouraging me to power through. Dr. Li-Teng Chen, thank you for patiently fielding questions and taking your time to teach me at a pace that piloted my course for research. I never dreamed that I would find so much delight in statistics.

I want to thank my colleagues on Dr. Jeon's research team who constantly uplifted me through the wavering and turbulent emotions triggered by grad school. Thank you to all of you for having my back and offering direction when I was feeling overwhelmed. Nina McCartney, thank you for your optimism combined with your sage advice which steered me through choppy times. Victor Richard, thank you for your readiness to accompany me (i.e., chauffeur) when recruiting teachers at all the several programs. Marta Czastkiewicz, thank you for providing your camaraderie and support and joining the many excursions around town to recruit teachers.

I would like to thank the many wonderful people who played big parts in supporting me through this process with their kind words and constant encouragement, taking my children for a weekend, going for a bite to eat or sipping coffee, providing nourishment to my family and me, or just walking me through frustration and tears. Thank you, Kim and Doug Johnson, Tara and Paul Goodfellow, Jen and Tyson Johnson, Grammy Jean, Tamara Hummel, Valerie Ortiz, Shelby Hunt, Diane and Paul Smith, M. Georganne Marx, Desiree Leland, Vicki Pillars, Holly DeMeulenaere, Kelci Binau, Aljwharah Alfwzan, and many, many others.

I would like to send a special thank Lauren Martelle, Stephanie McKnight, Tara Hill, and all the ECE program directors and ECE teachers who supported and participated in this study. I am so grateful for you; not just for your contribution to this study, but also for all you do with and for our young children. I truly believe that your experiences and voice are the gateway to the science and research we need to advocate to improve ECE policies and bring about change. Your work (and play) with our youngest population is crucial and invaluable to shaping the world as it will grow to be.

Lastly, and never least, I thank God for blessing me with such wonderful people, easing my anxiety, and guiding me through each day to get here.

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Chapter One: Introduction

Early science learning has received growing attention over recent decades, bringing a focus on improving scientific literacy and achievement and cultivating a scientifically and technologically skilled labor force (Buchter et al., 2017). Technological advances in the fields of science, technology, engineering, and mathematics (STEM) and the increasing demands for skills and science concepts for the labor market necessitate that early science learning becomes a forefront issue to researchers, educators, and policymakers (Buchter et al., 2017). Teachers concur that early science learning piques children's interest, engages their attention, and motivates them to participate in science activities (French, 2004). Early childhood is an optimal time for providing and fostering STEM learning foundations since it is also a sensitive period of brain and cognitive development (Buchter et al., 2017; French, 2004). Well before entering kindergarten, young children being inherently inquisitive and curious possess the motivation and ability to pursue and connect information and observations (French, 2004). Young children can understand some cause and effect sequences and are capable of employing science learning processes such as developing writing skills, observing, hypothesizing, and checking their predictions (Gelman & Brenneman, 2004).

However, while many elementary and secondary teachers are charged with incorporating science instruction in their curriculum (*Every Student Succeeds Act*, 2015; Office of Science and Technology Policy [OSTP], 2019), children's science proficiency in the U.S. lags in comparison to other countries with the U.S. ranking 15 out of 54 countries for 4th grade and 17 out of 43 for 8th grade (National Center for Education Statistics [NCES], 2017). Further, 38% of U.S. 4th graders, 34% of 8th graders, and 22%

of 12th graders are at or above proficient standards for science achievement (National Assessment of Educational Progress, 2015). Fewer studies have examined young children's science proficiency before entering kindergarten (Greenfield et al., 2009; Guo et al., 2015) despite the fact there are suggested science curriculum standards (National Association for the Education of Young Children [NAEYC], 2017; 2019; National Science Teachers Association [NSTA], 2014). However, even with recommendations for science learning, data remains limited because U.S. preschools are not regulated by the same standards as primary and secondary education. Indeed, early care and education (ECE) teachers emphasize science instruction much less than that of literacy and other subjects (Brenneman et al., 2009; Gerde et al., 2018; Tu, 2006). When learning centers (e.g., art, dramatic play, science, etc.) are incorporated in the ECE classroom, the science center often receives the least attention by the teachers (Nayfeld et al., 2011; Pendergast et al., 2017; Tu, 2006).

The incongruity between the emphasis on early science learning and actual classroom practice may be traced to the attitudes and beliefs of the ECE teacher. Numerous factors may explain the hesitance and lack of scientific instruction, including limited pre-service training, insufficient science-specific knowledge, and inconsistent use of science knowledge (Andersson & Gullberg, 2014; Andersson et al., 2019). These factors relate to a teachers' beliefs of their self-efficacy and confidence in teaching and supporting student outcomes (Bandura, 1977; Gibson & Dembo, 1984) and reflect on their attitudes in teaching and classroom behavior (Fives & Buehl, 2012). ECE teachers' self-efficacy reflects their degree of confidence in their science teaching abilities and their beliefs that student learning is under their control (Gibson & Dembo, 1984).

Because ECE teachers are not required to have more than a GED or high school diploma in the states, teachers may lack proper science teaching preparation whether through formal education or professional development. Teachers that do pursue higher education may only be required to take a few science-based courses if any at all. Thus, ECE teachers often are not prepared with science-domain content knowledge.

Additionally, ECE teachers with less educational attainment may work in lower-paying programs and may not receive the same training opportunities to stay current on science teaching. Program characteristics may be important to consider when examining teachers' attitudes and beliefs towards teaching science to young children. Discrepancies of quality learning have been found to exist in low-income communities when compared to high-income communities (Bassok & Galdo, 2016). Teachers in these programs may have unique circumstances that drive their feelings toward teaching science. Along with insufficient science-specific knowledge and pre-service training, ECE teachers' attitudes toward teaching science may also include their beliefs about young children's capabilities and the resources available in their program (Andersson & Gullberg, 2014). Therefore, while ECE science standards are increasing to encourage ECE teachers to provide science curriculum, the expectations may or may not equate to the teachers' actual practices and classroom activities.

Problem Statement

Providing high-quality early childhood science experiences are crucial for young children's school readiness. However, the issue remains that many ECE teachers may have less favorable attitudes and beliefs towards teachings science (Cho et al., 2003; Coulson, 1992; Edwards & Loveridge, 2011; Greenfield et al., 2009). They may not be adequately trained in teaching science nor confident in providing developmentally appropriate and quality science instruction. In order to advocate for change in the ECE classroom, it is important to examine ECE teachers' attitudes and beliefs and how they relate to classroom practices. Research is growing regarding teachers' attitudes and beliefs toward teaching science, yet few studies examine the attitudes and beliefs of ECE teachers in terms of their professional as well as their program characteristics and their classroom practices (Cho et al., 2003; Erden & Sönmez, 2011; Greenfield et al., 2009; Maier et al., 2013; Spektor-Levy et al., 2013). The present study aims to add to the literature and narrow this gap.

The Current Study

The current study aims to investigate what teacher characteristics (i.e., age, education level, years of experience, wage, and science-related professional training) are linked to ECE teachers' attitudes and beliefs toward teaching science to young children. The study also considers relationships between program characteristics (i.e., program type—private or public and neighborhood income) and ECE teachers' attitudes and beliefs toward teaching science to young children. The study also proposes to examine whether ECE teachers' attitudes and beliefs are related to the classroom environment in terms of teacher-reported science teaching behaviors, science-related toys and materials in the classroom, and frequency of science-related activities and lessons in the classroom.

Definition of Terms

Attitudes

Attitudes are the negative or positive degree of sentiments or learned evaluations that a person holds for or against someone or something (Ajzen & Madden, 1986;

Koballa & Crawley, 1985). Attitudes may be shaped on the premise of what an individual believes to be true and are related to a person's behavior (Fishbein & Ajzen,1975; Riggs & Enochs, 1990).

Beliefs

Beliefs are the subjective portrayal of information an individual considers and holds to be true and often provide the foundation for determining one's attitudes toward someone or something (Fishbein & Ajzen, 1975; Koballa & Crawley, 1985; Riggs & Enochs, 1990). Beliefs, like attitudes, are linked to whether an individual performs or does not perform a behavior (Bandura, 1977) and are based on perception of social norms and one's control over the behavior (Ajzen, 1991).

Child Benefit

Child benefit refers to teachers' attitudes and beliefs towards the value and advantages of early science learning for the child (Maier et al., 2013). For example, early science learning nurtures young children's science interest and enhances young children's approaches to learning, helping to cultivate skills for school readiness (Greenfield et al., 2009; Spektor-Levy et al., 2013).

Early Childhood

Early childhood is often defined as the stage from birth to age 8. The current study refers to early childhood as the period after toddlerhood and before entering primary school, or children from the ages of 2 to 5.

Outcome Expectancy Beliefs

The term outcome expectancy refers to the conviction of the likelihood that a behavior or action will result in a specific consequence or outcome (Bandura, 1977).

Teacher outcome expectancy beliefs refer to the level that teachers believe their teaching is effective in influencing student outcomes (Riggs & Enochs, 1990). Teachers act on a behavior when they anticipate it will generate desirable consequences or outcomes (Riggs & Enochs, 1990).

Private Program

Private programs are those center-based programs that may be nonprofit (i.e., grant-funded) or for-profit (tuition-funded) but not funded by the government. These programs may include faith-based and community-based programs as well as privately funded licensed programs.

Public Program

Public programs are government-funded that seek to enhance social and cognitive development for low-income children and those with special needs (Swadener, 1995). Public programs in the current study include Head Start, state-funded Pre-K, and the local school district early childhood services. Public programs, such as Head Start, often require more rigorous staffing qualifications (i.e., at least an associate degree in child development or equivalent) and evaluative data collection to monitor program quality and performance standards (Head Start Performance Standards [HSPS], 2016).

Teaching Self-Efficacy Belief

Self-efficacy is one’s personal belief in their competence and capabilities to teach and effectively contribute to student learning (Bandura, 1977; Gibson & Dembo, 1984; Tschannen-Moran & Hoy, 2001). Teacher self-efficacy is based on a combination of teachers’ beliefs of their teaching abilities in a subject and the belief that their teaching will influence student achievement and understanding of that subjects' concepts (Riggs & Enochs, 1990).

Teacher Challenges

Teacher challenges encompass negative attitudes and beliefs which teachers hold toward teaching science (Maier et al., 2013). Teachers' discomfort in teaching science can stem from beliefs that they have insufficient science content and process knowledge, limited science-related resources and materials, and lack of time to plan and present science activities (Maier et al., 2013). Perceptions of fewer teacher challenges indicates more positive attitudes and beliefs toward science teaching.

Teacher Comfort

Teacher comfort reflects the degree of assurance and ease in planning, preparing, and conducting science activities (Maier et al., 2013). Comfort also encapsulates how a teacher feels in responding to children's science questions and demonstrating how to use science-related materials in the classroom. Collecting materials, seeking resources, gathering ideas, and doing science in the classroom portray greater comfort in teaching science.

Research Questions

1. Do ECE teachers' attitudes and beliefs towards teaching science (i.e., child benefit, teacher challenges, teacher comfort, self-efficacy, and outcome expectancy) relate to their classroom practices (i.e., science-related teaching methods, science-related materials in the classroom, and time dedicated to providing science activities)?

2. Do ECE teachers' professional characteristics (i.e., education level, science-specific professional development, years of experience in the field, wage) relate to their attitudes and beliefs towards teaching science to young children and their classroom practices?
3. Do ECE teachers' program characteristics (i.e., program type, neighborhood income) relate to their attitudes and beliefs towards teaching science and their classroom practices?

Hypotheses

1. H_{01}. ECE teachers' attitudes and beliefs toward teaching science to young children (i.e., child benefit, teacher challenges, teacher comfort, self-efficacy, and outcome expectancy) does not relate to classroom practices (i.e., science teaching behaviors, science-related materials in the classroom, and time dedicated to providing science activities).
2. H_{02}. ECE teachers' professional characteristics (i.e., education level, science-specific professional development, years of experience in the field, wage) do not relate to their attitudes and beliefs towards teaching science to young children or their classroom practices.
3. H_{03}. ECE teachers' program characteristics (i.e., program type, neighborhood income) do not relate to their attitudes and beliefs towards teaching science or their classroom practices.

Chapter Two: Literature Review

Research on teachers' attitudes and beliefs toward science has long been considered in how these influence teachers' science-teaching practices and students' learning (Cho et al., 2003; Erden & Sönmez, 2011; Koballa & Crawley, 1985; Maier et al., 2013). This chapter addresses a theoretical framework that explains the relationship between attitudes, beliefs, and behaviors. The chapter then considers the relevance of providing science experiences to young children. Finally, the chapter focusses on the research addressing teacher attitudes and beliefs toward teaching science.

Attitudes, Beliefs, and Behaviors Theoretical Framework

The current study emerges from the assumption that attitudes and beliefs drive behavior (Ajzen, 1991; 2005; Bandura, 1977). Attitude is a construct based on an individuals' predisposition to evaluate something or someone in a favorable or unfavorable context (Ajzen, 1991; 2005; Eagly & Chaiken, 1993). Attitudes are the combined evaluations, or feelings, one has towards an object, person, institution, or event and depicted as either negative or positive (Ajzen, 1991; 2005; Ajzen & Madden, 1986; Koballa & Crawley, 1985) and may be established and influenced by beliefs (Riggs & Enochs, 1990). Clearly distinguishable from attitudes are beliefs which are the information that an individual perceives and accepts as being true (Fishbein & Ajzen, 1975; Koballa & Crawley, 1985) and have also been linked to behavior (Bandura, 1977). Once attitudes are formed, they can be constant and difficult to change (Herrington et al., 2016).

According to the theory of planned behavior (Fishbein & Ajzen, 1975), intention is the most salient factor for an individual to perform or not perform a behavior.

Individuals consider the consequences of their actions before they choose to carry out a behavior (Ajzen, 2005). The theory of planned behavior suggests that there are three basic elements to intention: attitude, which is based on the individual's personal nature; subjective norms, based on what other people think of the behavior; and perceived behavioral control, which reflects the individual's view of the amount of control they have over the behavior (Ajzen, 2005). These elements are significantly linked to an individual's basic beliefs regarding the behavior in question (Ajzen, 1991).

Attitude responses can be divided into three subcategories: cognitive, affective, or conative (Ajzen, 2005; Eagly & Chaiken, 1993; Herrington et al., 2016). Cognitive responses reflect verbally a person's beliefs with characteristics or attributes of the event, object, or person in question or their perceptual responses (Ajzen, 2005). Affective verbal responses reflect verbal evaluations and feelings (i.e., "I enjoy" or "I feel") or emerge as physiological in nature (e.g., facial expressions, heart rate, or pupil dilation; Ajzen, 2005). Conative verbal responses are expressed verbally in behavioral inclinations, intentions, commitments, and actions or can also be exhibited in overt behaviors (Ajzen, 2005).

Subjective norms are the beliefs or convictions, which one has formed through experience, whether or not they are based on fact (Ajzen, 1991; 2005; Fishbein & Ajzen, 1975). Subjective norms are what one thinks others think about the behavior, whether the behavior is important or not important to others, and if others would approve or not (Ajzen, 2005). It is the "person's perception of social pressure to perform or not perform the behavior under consideration" (Ajzen, 2005, p. 118). Subjective norms can be formed through direct experiences or accepted information (Ajzen, 1991; Fishbein & Ajzen, 1975).

Perceived behavioral control describes the amount of power and choice a person considers that they possess to perform or change the behavior (Ajzen, 1991). Ajzen (2005) asserted that it is not how much actual control a person has but their perception of control, or when "they believe that they have the means and opportunities to do so" (p. 118). Thus, individuals that believe they have the means and resources to perform a behavior may have a stronger inclination to perform.

The dimension of perceived behavioral control corresponds with the construct of self-efficacy within Bandura's (1993) social cognitive theory. Perceived self-efficacy is described as the belief systems that are formed by a person's perceived confidence in accomplishing a task and their control over their environment (Bandura, 1993). Individuals with higher self-efficacy beliefs, or greater perceived behavioral control, are more likely to perform the behavior even when the environment hinders the opportunity to perform the behavior (Bandura, 1977; 1993). Bandura (1977) argued that self-efficacy was situation-dependent and could be best explained by two factors: personal efficacy and outcome expectance. Personal efficacy is an individual's certainty in their skill and capability to successfully perform a behavior. Outcome expectancy is the belief that the person's performance of the behavior will influence others. People's beliefs about their self-efficacy shape their intention to perform a behavior and their actual practice of the behavior (Ajzen, 1991; Bandura, 1977; 1993).

ECE Teachers' Attitudes and Beliefs Towards Science Teaching

Through the lens of the theory of planned behavior and the construct of self-efficacy, the components of ECE teachers' attitudes and beliefs towards science may predict the behavior (i.e., teaching science). The subcategories of attitudes form a framework of the usefulness of the theory. Cognitive responses, for example, are demonstrated by the teacher's belief that science instruction is important versus irrelevant or the belief that science is difficult (Cho et al., 2003; Herrington et al., 2006; van Aalderen-Smeets & Walma van der Molen, 2013). Affective responses can be realized by teachers' emotions or feelings, such as science is enjoyable, or conversely a trigger for anxiety (Herrington et al., 2016; van Aalderen-Smeets & Walma van der Molen, 2013). Conative responses are what lead to the action (Herrington et al., 2016). A conative response can be seen when a teacher verbalizes their refusal or agreement to teach young children science or nonverbal such as a teacher self-educating on science concepts and early childhood teaching or encouraging young children to be scientists (Eagly & Chaiken, 1993; van Aalderen-Smeets & Walma van der Molen, 2013). Teachers' actual practices may largely depend on their perception of control in terms of their perceived level and sense of their capabilities and the modifiability of the environment (Ajzen, 1991; 2005; Bandura, 1993).

As noted above, teachers' attitudes and beliefs shape their teaching practice and behavior (Ajzen, 1985; Bandura, 1977). Beliefs are information which an individual perceives as true (Koballa & Crawley, 1985). Self-efficacy beliefs toward teaching are the teachers' beliefs of their ability to teach effectively and increase children's learning (Gibson & Dembo, 1984). Based on beliefs about teaching science, attitudes toward teaching science are the systematized beliefs that influence positive or negative responses (Cho et al., 2003; Herrington et al., 2016; Riggs & Enochs, 1990). Teachers' attitudes toward teaching science and self-efficacy beliefs are powerful predictors of their actual classroom practices (Bandura, 1977; Haney et al., 1996). However, Pendergast et al.

(2017) conveyed that despite teachers' positive attitudes and beliefs toward teaching science to young children and their beliefs of the importance of providing science centers, teachers felt uncomfortable using science-related tools and reported inadequate science knowledge. With increasing attention for curriculum reform and standards in teaching science to young children, ECE teachers' hesitance in or motivation for teaching science (Brenneman et al., 2009; Tu, 2006) may emerge from their attitudes and existing beliefs; thus, it is important to identify what influences teachers' attitudes and their beliefs toward teaching science and how they are related to their classroom practices.

The Importance of Early Science Inquiry for Young Children

Investing in human capital through education has long been considered an important contribution to economic productivity (Dickens et al., 2006). A better-educated labor force adapts to perpetually changing tasks and skills, provides innovative thinking in work management, and adjusts to changing technology. With global movement and advancements in science and technology, teaching science in and before the elementary school years has become a central issue of policy reform in advancing a better-informed labor force and competing on a global level (Buchter et al., 2017; Greenfield et al., 2009). Since a large number of children spend their time in an ECE program, ECE teachers are fundamental in supporting and fostering young children's science learning by providing rich science learning environments (Gropen et al., 2017). Researchers, educators, stakeholders, and policymakers underscore the importance of high-quality early learning on the trajectories for a growing generation of children ages three to five who are in the charge of care outside the home (National Research Council, 2001; NICHD Early Child Care Research Network, 2006). Like most learning and development at this age, strong science learning foundations demand high quality and effective instruction and experiences (Greenfield et al., 2009).

Over the past couple of decades, educational reform has pushed for cultivating a thriving STEM-based economy by not only putting greater attention and emphasis on providing quality science teaching in elementary and secondary schools (OSTP, 2019; U.S. Congress Joint Economic Committee, 2012; Zack et al., 2017) but also in early childhood programs (Brenneman et al., 2009; NSTA, 2014). Much of the reasoning behind this push lies in the belief that just as high-quality early learning experiences are crucial for school readiness and academic success (Belsky et al., 2007; NAEYC, 2009), high-quality science experiences may also increase later student achievement and engagement in science (Brenneman, 2011; Morgan et al., 2016) and comfort with science later in life (Brenneman, 2011; Eshach & Fried, 2005). Indeed, Morgan et al. (2016) found that children entering kindergarten with significant gaps in general knowledge of earth, physical, and life sciences retained general knowledge gaps in the first grade. General science knowledge gaps predicted science achievement gaps which persisted over time as assessed in students' third, fifth, and eighth grades (Morgan et al., 2016). These gaps were also related to lower reading and mathematics achievements in third, fifth, and eighth grades (Morgan et al., 2016). Thus, research and educational experts concur that early science exposure is important for establishing optimal and improving academic trajectories (Buchter et al., 2017; Eshach & Fried, 2005; NSTA, 2014).

Children's Cognitive and Brain Development

Child development experts agree that children from ages 0 to 5 years old are at a fundamental period of their lives for optimum development, especially within the domains of cognition and brain growth. In fact, children produce over 700 synaptic connections every day within the first three years of their lives, making this period of development ideal for discovering and understanding new concepts (Buchter et al., 2017). Birth to age 5 is a critical period for brain development and lays the foundations for all domains of development, including physical, cognitive, language and communication, and socioemotional (Office of Head Start, 2015). Development during this time is described as a sensitive period because of the rapid growth of synaptic connections with connections that are not used being pruned or eliminated. Moreover, children's cognitive and brain development (Buchter et al., 2017), their innate curiosity and motivation to observe, explore, and ask questions, as well as their ability to develop an understanding of science concepts provide the opportunity for adults to foster early exposure (Eshach & Fried, 2005; Gelman & Brenneman, 2004; NSTA, 2014). Early science experiences support increased understanding of scientific concepts (Eshach & Fried, 2005; NSTA, 2014), promote other learning across subjects such as mathematical, language, and socioemotional development (Gelman & Brenneman, 2004) and nurture positive attitudes toward science (Eshach & Fried, 2005).

Children's Natural Curiosity and Competency

Complementing this sensitive period of learning, children have an innate curiosity, eagerness, and ability to act on their inquisitiveness. Young children interact with their environment and through natural curiosity, begin navigating and exploring their world through using their senses, asking questions of and interacting with each other and adults, testing hypotheses, and thinking abstractly about problems (Piaget, 1952). As more becomes known about the capabilities and aptitudes of children, research has demonstrated the need to provide science instruction even before children enter primary school. For example, Gelman and Brenneman (2004) emphasized that young children possess complex thinking and the ability to take new information and build on what they already know and form new schemas. Children demonstrate their natural capacity to engage in scientific processes as they attempt to explain phenomena by asking questions, hypothesizing, predicting, theorizing, collecting and organizing data, and drawing conclusions (Frazier et al., 2009; French, 2004; Fusaro & Smith, 2018; Spektor-Levy et al., 2013). Nonetheless, timing is of the essence. Research suggests that scientific inquiry emerges during a sensitive period, and postponing science inquiry until kindergarten wastes crucial years of engagement and development (Buchter et al., 2017). When children lack schemas for particular domains, new information remains unimportant to them (Gelman & Brenneman, 2004). Thus, because of their natural curiosity and eagerness to learn, early childhood is an ideal time to provide exposure to scientific inquiry (Eshach & Fried, 2005; Spektor-Levy et al., 2013).

Early Science Relates to Other Learning Skills

ECE teachers implement curricular subjects in the ECE classroom such as mathematics, language, and literacy that are considered fundamental skills for engaging in science (Gelman & Brenneman, 2004). For example, language and literacy skills are needed for science processing skills such as when children verbalize observations, record with drawings, communicate, and collaborate. They incorporate mathematical skills with scientific skills when they measure, estimate, count, and record. Children are capable of learning conceptual language within domains of science, like “observe,” “predict,” and “record” – all vocabulary related to the scientific method (Gelman & Brenneman, 2004).

Studies have found that engaging in science experiences correlated with children's vocabulary development and provided a foundation for language and literacy activities as well as communication and socioemotional skills (Brenneman et al., 2009; French, 2004). Science experiences enrich language and literacy development as children are exposed to vocabulary that is common in science but not in other subjects (Brenneman et al., 2009; McClure et al., 2017). French (2004) assisted in the design of a socially active early childhood science curriculum that integrated science with standard classroom curriculum, i.e. social studies and math. After implementing the program, ECE teachers reported their surprise in young children's acquisition and retention of advanced vocabulary (French, 2004). Interestingly, teachers also reported that children problem-solved, interacted with peers and adults, and demonstrated self-regulation with less challenging behavior and inattentiveness—all skills outside the realm of just basic science knowledge content (French, 2004). Thus, early science learning helps to foster skills important for school readiness and encourages motivation and inspiration to pursue STEM careers (Buchter et al., 2017).

Early Exposure Nurtures Children's Positive Attitudes towards Science

Attitudes are learned characteristics that may take years to acquire (Koballa & Crawley, 1985), which is why it is important to provide young children with high-quality science experiences to cultivate positive attitudes toward science. For instance, young children who are provided more frequent opportunities to engage in science activities express more positive attitudes towards science (Simsar, 2018). Additionally, children who have access to higher quality, or well-designed science areas or centers in the classroom, exhibit more positive attitudes towards science (Simsar, 2018). Thus, early science exposure helps children to navigate their world while encouraging their curiosity and fostering early thinking and learning skills but also supports positive attitudes towards science by building their confidence and comfort in doing science (Brenneman, 2011; Brenneman et al., 2009; Eshach & Fried, 2005). Indeed, Andersson and Gullberg (2014) suggest the most important benefit of providing science activities to young children is not to stimulate engagement or to meet the economic need to fill science positions but the empowerment and satisfaction the children acquire. Children become confident with and reliant on their abilities to ask questions and seek answers, not only in science but also in other areas of life (Andersson & Gullberg, 2014). Thus, children's positive attitudes toward science are necessary as they support school readiness (Brenneman et al., 2009), bolster motivation and achievement (Eshach & Fried, 2005), and influence future science engagement in school, the workforce, and daily life (Brenneman et al., 2009).

The ECE Teachers' Role in Providing Science Instruction

Effective and responsive teacher child-interactions (Hamre et al., 2014) and high-quality early experiences accentuate development and support young children's school readiness and future outcomes (French, 2004). According to Vygotsky (1978), adult guidance through social interaction provides experiences and enhances children's learning thus establishing the ECE classroom as an ideal environment for fostering early learning. Teachers who are responsive in their interactions with young children are more likely to actively and intentionally engage children and support learning and thinking skills (Hamre et al., 2014). Accordingly, adult interaction is crucial in children's increase and durability of science knowledge (NSTA, 2014) and the development of higher-order thinking skills (Cabell et al., 2013). Nayfeld et al. (2011) observed that despite young children's natural inquisitiveness, they rarely engaged in the science area during autonomous exploration, especially in comparison with other centers in the classroom. However, after an intervention, Nayfeld et al. (2011) found that children's attention and exploration in the science area increased with adult-guided learning and interaction with science tools and objects. Activities and opportunities implemented and led by adults actively engaged children in science inquiry—observing, questioning, and reporting (Nayfeld et al., 2011).

As facilitators of children's engagement and learning (Hamre et al., 2014), Nayfeld et al.'s (2011) study clearly illustrated that the teachers' role in early childhood is crucial to science learning. The ECE teachers' role in supporting and providing ample and varied opportunities is essential in young children's science learning. However, as state policies are stepping up and promoting an emphasis on ECE programs introducing and providing science instruction, it is important to understand the attitudes and beliefs of teachers toward teaching science to preschoolers and investigate the actual practices and classroom environment. While more programs and teachers are implementing early STEM curricula (Englehart et al., 2017; French, 2004), some teachers are still hesitant to teach science, exhibit less science-learning interactions and support, and make science less a priority than other subjects, such as literacy and mathematics (Brenneman et al., 2009; Tu, 2006).

Attitudes, Beliefs, and Science Content Knowledge

In a study examining ECE teachers' self-efficacy across domains of literacy, science, and mathematics, Gerde et al. (2018) discovered a glaring gap between teachers' self-efficacy in science and literacy with science self-efficacy ranking much lower. Teachers have often reported that they feel unprepared to teach science and view their science knowledge as inadequate in being able to teach science and answer science-related questions (Edwards & Loveridge, 2011; Greenfield et al., 2009; Pendergast et al., 2017; Torquati et al., 2013). ECE teachers whose programs do require formal education revealed that they still received limited science-related coursework in preservice education and professional training and limited support in teaching science to young children (Brenneman et al., 2009). Other teachers reported that administrators and district/state personnel failed to provide effective professional training if it was offered at all (Park et al., 2017). In one study, even those teachers who reported greater self-efficacy in planning and conducting science activities felt their science knowledge was limited (Pendergast et al., 2017).

Many ECE teachers indicated that science instruction should begin early but concurred that they have limited science content knowledge and thus felt inept in planning science activities (Spektor-Levy et al., 2013). One teacher interviewed by Park et al. (2017) insisted, “My knowledge about STEM is so limited it would not be a good idea for me to teach STEM to my precious little students” (p. 284). Further reports indicated ECE teachers’ low-self efficacy was related to their hesitance in using science-related materials provided in the classroom (Greenfield et al., 2009). Greenfield et al.’s (2009) teachers claimed their science knowledge was insufficient. Likewise, ECE teachers agreed that limited training and development is offered that enhances science knowledge in early science education (Spektor-Levy et al., 2013).

Attitudes and Beliefs and the Classroom

Time for Teaching Science. The ECE classroom is fast-paced, busy, and chockful of activities and expectations. Piasta et al. (2014) argued that with the contemporary increase of attention to early learning standards and national initiatives and more attention on early science curricula may have contributed to and augmented teachers' knowledge and self-efficacy. Gibson and Dembo (1984) found that teachers with high self-efficacy devoted more time in the classroom to student learning. Pendergast et al. (2017) indicated more than half of prekindergarten lead teachers felt they had plenty of time to teach science on a daily basis. On the other hand, teachers' hesitance in instructing science can be influenced by time management. Due to the demands to focus on other subjects (e.g., literacy and math), many teachers have reported not having enough time to add science to their scheduled curriculum (Greenfield et al., 2009; Park et al., 2017) despite ECE teachers' having ample access to science materials within their programs (Greenfield et al., 2009; Tu, 2006).

Materials and Activities. Teachers' self-efficacy in teaching has been associated with teachers' creating an optimal learning environment (Bandura, 1993; Gibson & Dembo, 1984). More than providing didactic science instruction, ECE teachers are facilitators in engaging young children in science in a suitable physical and social environment with science resources, materials, and activities (Tu, 2006). Learning centers in ECE classrooms provide children with accessibility to free exploration with guidance from teachers to introduce new materials and demonstrate and support material use (Cabell et al., 2013). In an investigation of science environments in ECE classrooms, Tu (2006) found ECE teachers had the fewest teacher-child interactions in the science center

(13%) than other learning centers that are typical in an ECE classroom (e.g., art, dramatic play, literacy, manipulative, science, etc.), despite having ample science materials (e.g., vinyl animals, plants, sensory tables, prisms, binoculars, etc.). This is disturbing because while several teachers report that science discovery centers in the classroom were important, not all teachers felt comfortable in using the tools in these centers (Pendergast et al., 2017), and children rarely explored the science discover center by themselves (Nayfeld et al., 2011). However, when children observed adults engaging and using tools in the science center, children's interest was sparked (Nayfeld et al., 2011).

Gerde et al. (2018) indicated that ECE teachers who reported greater confidence with teaching science also described providing more science materials, experiences, and instruction to their young children. Thus, teachers' beliefs and attitudes may be the driving factor to engage children in science activities, demonstrating science tool use, and exploring science materials to support science learning. However, Erden and Sönmez (2011) found that ECE teachers with reasonably positive attitudes towards teaching science did not equate to a higher frequency in science activities. The authors suggest that the discrepancy may stem from a lack of science knowledge or limited resources and materials in the classroom.

Unfortunately, not all ECE programs are alike and may not have resources and knowledge to design a science discovery center or science-rich environment. In a small study of 20 preschool teachers, Tu (2006) video-taped classrooms to investigate the science environment. While many classrooms had science materials such as vinyl animals (80%) and plants (70%), half of the classrooms did not have a designated science center or science area (Tu, 2006). Similarly, Gerde et al. (2018) found that while basic science materials exist in the classroom (e.g., books, vinyl animals, magnets, magnifying glasses), more meaningful toys and materials (e.g., prisms, pulleys, fossils) that facilitate children's exploration were rare. In alignment with the theory of planned behavior (Ajzen, 2005), even if teachers have positive attitudes and believe that teaching science is beneficial and appropriate for children and what society wants them to do (i.e., follow curriculum standards), their behavior or classroom practices may contrast with their beliefs if they do not have the proper resources, materials, or training to teach young children (Park et al., 2017).

Beliefs about Young Children's Abilities

The evidence indicates young children possess the ability to understand scientific concepts and to apply scientific content (French, 2004; Greenfield et al., 2009; Nayfeld et al., 2011). However, views still persist that young children lack the ability to engage in abstract reasoning needed to comprehend science without regard to understanding that science can be as simple as observing and recording and that children further develop science skills when provided high-quality and effective learning opportunities (Flavell, 1963; Metz, 2009; Piaget, 1952). Some teachers have emphasized that young children are unable to grasp science concepts because concepts are too abstract, and children lack basic skills and knowledge (Park et al., 2017). Conversely, many ECE teachers have adopted the belief that young children possess the ability to engage in abstract language and cognitively challenging conversations (Massey, 2004), skills that can foster science inquiry. Further, ECE teachers have divulged beliefs that young children should be exposed to science at an early age despite their limited abilities to engage in abstract thought (Spektor-Levy et al., 2013). Moreover, Park et al. (2017) confirmed that teachers who believed STEM education was appropriate and essential for young children felt more prepared to teach STEM in their ECE classroom.

Teacher Characteristics and Attitudes and Beliefs

Education, Professional Training, and Teaching Experience. Teachers who participated in science-related professional training reported more positive attitudes toward teaching science in terms of comfort of planning and doing science activities with young children (Aldemir & Kermani, 2017; Pendergast et al., 2017). They were also more likely to believe that science activities support young children in developing mathematical and social skills (Pendergast et al., 2017). Teachers with science-specific training were more likely to engage in inquiry-based teaching and developed increasing comfort and confidence in teaching science (Lippard et al., 2018). Inquiry-based teaching engages students with a hands-on investigative approach to problem-solving and seeking solutions through experiments, observation, asking questions, and exploring solutions (Furtado, 2010). In Lippard et al. (2018), ECE preservice teachers expressed negative and mixed feelings toward science. Course materials consisted of limited science curricula and recommended readings but not activities to implement with young children (Lippard et al., 2018). In a study examining eighth-grade teachers, Kolbe and Jorgensen (2018) found that teachers with science degrees (i.e., engineering and science) and those with graduate-level degrees were more likely to use inquiry-based teaching to engage students. In contrast, those with little formal science education were less likely to use inquiry-based instruction (Kolbe & Jorgensen, 2018). Even teachers with an undergraduate minor in science adopted inquiry-based teaching as their careers progressed (Kolbe & Jorgensen, 2018). While these findings are based on examination of secondary teachers, ECE teachers' levels of education greatly vary as ECE programs are less regulated and do not require a high school degree or equivalent, much less a post-secondary degree with a science emphasis. Nonetheless, consistent with Kolbe and Jorgensen's (2018) findings, ECE teachers' higher educational attainment was linked to a higher frequency of science-related activities (Erden & Sönmez, 2011; Piasta et al., 2014). Correspondingly, Piasta et al. (2014) found teachers with a college degree provided more science-related learning opportunities to preschoolers. However, preservice teachers in Lippard et al. (2018) reported participating in fewer than one science course in college compared to a little more than four science classes required in high school.

Teachers that received science-related professional training felt more at ease in planning and enjoy conducting science activities with young children (Aldemir & Kermani, 2017; Pendergast et al., 2017). After a STEM intervention program, Pre-K teachers acknowledged an increase in comfort and confidence in planning and implementing science concepts (Aldemir & Kermani, 2017). Furthermore, Thulin and Redfors (2017) found that science-specific coursework for pre-service teachers resulted in a shift in science understanding and thinking. After participating in the course, pre-service teachers with a negative view of science changed to more positive views with many expressing an increased interest in science and belief that science was not as difficult as previously thought (Thulin & Redfors, 2017). These pre-service teachers also demonstrated the transition of teacher-led versus child-led perspectives to a belief that both children and the teacher are mutually involved in successful science activities and science learning. Thus, the study demonstrated that science-specific training can enhance science content knowledge which may support teachers' self-efficacy. The findings are important because teachers' lack of science knowledge may be related to an eroded sense of self-esteem and self-confidence in teaching science (Andersson & Gullberg, 2014).

The number of years a teacher is in the ECE field was positively related to their ECE beliefs in their ability to teach STEM and their belief that STEM education was important for young children (Park et al., 2017). However, teachers in Park et al. (2017) that did not recognize the importance of early STEM education did not feel ready to teach STEM whether they had more years of experience teaching or not. This corresponds with Kolbe and Jorgensen's (2018) findings that teachers with science-specific educational attainment were more likely to engage in inquiry-based teaching regardless of their years of teaching.

Differences in Programs

While there is a plethora of ECE programs available, parents in more affluent communities have more opportunity to choose early childhood care that offers highly trained teachers (Bassok & Galdo, 2016; Wrigley, 1989). Piasta et al. (2014) discovered that programs that served children from higher-income families were provided significantly more science learning opportunities. The choices are often more limited for parents with lower income in comparison to parents of with more affluence (Swadener, 1995) which is concerning as achievement gaps persist between children in high- to low-income communities (Morgan et al., 2016; Reardon & Portilla, 2016), especially in science (Greenfield et al., 2009).

High-quality science experiences are crucial for all children (Pianta et al., 2016). However, low-income communities still exhibit differences in terms of classroom structural and process quality compared with high-income communities (Bassok &

Galdo, 2016; Coley et al., 2016). Structural quality is characterized by the classroom environment, child-teacher ratios, and teachers' educational attainment while process quality reflects the children's experiences in the classroom generated by the teachers' classroom practices (Cryer, 1999). Bassok and Galdo (2016) found that public pre-K teachers in lower-income communities provided less emotional and instructional support, but they had higher structural quality with lower child-teacher ratios and teachers with more experience. They suggest the structural quality may be due to regulated requirements for public pre-K programs (Bassok & Galdo, 2016). Stipek and Byler (1997) similarly found that teachers in low-income neighborhoods gravitated towards a didactic, basic-skills process quality for school readiness rather than a child-centered developmentally appropriate approach. When it comes to process quality with science-related activities, less emotional and instructional support may be an issue for children's science achievement.

One teacher in Park et al. (2017) voiced concern that students from low-income families were less likely to have science resources (e.g., technology). The teacher stated that because parents' early learning experiences did not include a STEM-based curriculum, STEM had less importance and support at home (Park et al., 2017). This scenario illustrates that teachers' self-efficacy can be determined by external factors in the environment (i.e., parent support) and the degree to which the teachers think they have control (Bandura, 1993). Within the construct of Bandura's (1993) self-efficacy, outcome expectancy is the degree in which teachers believe their teaching can overcome external factors, including children's home environment. Thus, teachers' actual practices in the classroom may be dependent on their beliefs of children's external factors, such as low-income and lack of home resources and support (Ajzen, 2005; Bandura, 1993).

A study examining ECE teachers in Turkey found differences in teachers working in public schools in comparison to those working in private schools in terms of attitudes toward teaching science and the occurrence of science activities in their classrooms (Erden & Sönmez, 2011). Public schools in Turkey, similar to Head Start and other public schools in the U.S. (HSPS, 2016), have standardized objectives and goals for young children in which teachers are responsible for meeting (Erden & Sönmez, 2011). Despite the specific objectives for public teachers, it is the teachers in private schools that provided more science activities (Erden & Sönmez, 2011). Erden and Sönmez (2011) explained private school teachers in Turkey have more access to materials and equipment and more professional development support. While the study was conducted in Turkey, the results warrant examining relationships between teachers' attitudes and beliefs and program type.

Additionally, teachers working in private programs located in low-income or disadvantaged neighborhoods may not have the same benefits or wages as those in affluent neighborhoods (Swadener, 1995). Private programs may require less formal training and/or credentials to employ teachers in comparison to public programs, such as Head Start (HSPS, 2016). Less training compounds ECE teachers limited opportunities to learn how to teach science, and thus, teachers may focus more on subjects in which they are more comfortable teaching. Therefore, programs with fewer resources and less support may not be providing adequate quality science instruction if teachers yield to lower expectations in teaching young children.

Summary

Providing young children with science learning opportunities is important in the early years because of the need to sustain economic productivity in the labor force; to support young children's cognitive and brain development, their natural curiosity, and their ability to reason; to close the achievement gap in science performance; and to cultivate young children's long-lasting, positive attitudes towards science. ECE teachers are primary facilitators in science instruction in the ECE setting. Their attitudes and beliefs toward teaching science to young children are important factors to consider because they may determine the quality of science instruction in the classroom. Thus, the current study examines not only ECE teachers' attitudes and beliefs towards teaching science but also their classroom practices. The study also examines the relationships between attitudes, beliefs, and practices with teachers' professional and program characteristics.

Chapter Three: Methods

Recruitment and Study Procedures

The present study employed a correlational design that examined the relationships between variables using a survey (Creswell, 2015). After approval of the University Institutional Review Board (see Appendix A), the research team contacted 70 of 98 licensed ECE programs including private (i.e., not government-funded) and public (i.e., Early Head Start, Head Start, State-funded pre-Kindergarten and university ECE laboratories) programs in a metropolitan area of a northwestern state in the U.S. In adopting a convenience sampling method, the research team contacted the directors of ECE facilities via phone or in-person, provided a description of the study, and requested the participation of lead and co-lead teachers of young children aged three to five. Teachers in classrooms with a combination of two- and three-year-old children were also allowed to participate. Of the programs contacted, 40 ECE programs agreed to participate in the study. With the program director's consent, an email collection form was disseminated to the lead and co-lead teachers in which those teachers could voluntarily provide their emails. The researcher arranged to return to the site to collect the email collection form if the form was not emailed back to the researcher. Participating programs collected 194 ECE teachers' emails. The researcher entered the emails into Survey Monkey, an online survey tool. A link to the questionnaire was then distributed to teachers via their email. The survey was also distributed by sending a direct link to email addresses of personally known ECE teachers in the county, e.g., teachers in the school districts.

The online survey's initial page provided informed consent with a description of the study and purpose, potential risks and benefits to participants, the estimated time requirements of about 20–30 minutes to complete the survey, information about the incentive for $10 e-gift card, and contact information for the primary investigator. After the introduction and to confirm voluntary participation, the participant checked a corresponding box to provide or not to provide consent. If participants chose not to consent, the survey ended. Participants could opt-out of the survey at any time without risk. Participants typically took 20 minutes to complete.

Participants

Of 194 teachers who were sent the link to take the survey, 47 didn't open the survey, seven participants opted out, and ten were disqualified because they were not lead or co-lead teachers. Twenty surveys were only partially completed and not included in this data analysis. The response rate of ECE teachers (N = 110) who completed the survey was 56.7%.

As displayed in Table 1, ECE teachers' age ranged from 18 to 67 with a mean of 35.95 (SD = 12.30). The majority of ECE teachers were women (n = 109). The sample predominately consisted of European American/White (74.5%) followed by Latin American/Hispanic (15.5%), Asian American/Asian (5.5%), African American/Black (3.6%), Native American/ Alaskan Native (1.8%), and Native Hawaiian/Pacific Islander (1.8%), with 5.5% identifying as biracial. Teacher's education included six levels in which 54.5% attained less than a bachelor's degree and 45.5% bachelor's degree or higher. A few ECE teachers (26.4%) reported they had received science-specific professional training or development. Less than half of teachers (45.5%) reported having fewer than five years in the ECE field, and 73.7% have been in their current program for fewer than five years. The majority of ECE teachers (85.5%) reported being employed full time.

Table 1

Demographic Characteristics of Participants

Variable	*n*	%	*M*	*SD*	Min	Max
Teacher's age (years)	110		35.95	12.30	18	67
Less than 20	3	2.7				
21-30	43	39.1				
31-40	29	26.4				
41-50	14	12.7				
51 +	21	19.1				
Sex	110					
Female	109	99.1				
Male	1	.9				
Ethnicity	110					
African American/Black	4	3.6				
Asian American/Asian	6	5.5				
European American/White	82	74.5				
Latin American/Hispanic	17	15.5				
Native American/Alaskan Native	2	1.8				
Native Hawaiian/Pacific Islander	2	1.8				
Biracial/Multiracial	6	5.5				
Highest Education	110					
Less than high school/GED	3	2.7				
High school/GED	38	34.5				
CDA	2	1.8				
Associate degree	17	15.5				
Bachelor's degree	40	36.4				
Master's degree	10	9.1				
Science-related PD	110					
Yes	29	26.4				

Variable	*n*	%	*M*	*SD*	Min	Max
No	81	73.6				
Experience in the field	105		9.37	9.15	0.17	48.50
Less than 1 year	6	5.5				
1-5 years	44	40.0				
6-10 years	20	18.2				
11-15 years	16	14.5				
16 + years	19	17.3				
Time in current program	107		5.15	6.30		
Less than 1 year	18	16.4				
1-5 years	63	57.3				
6-10 years	12	10.9				
11-15 years	6	5.5				
16 + years	8	7.3				
Wage (hourly)	110		15.95	6.12	8.75	40.00
Employment hours	110					
Full-time	94	85.5				
Part-time	16	14.5				
Program type	110					
Private	76	69.1				
Public	34	30.9				
Neighborhood income	110					
Low-income	66	60.0				
Not low-income	44	40.0				

Note. GED = General Education Development; CDA = Child Development Associate; Private = private orfaith-based program; Public = Federal- or state-funded programs; PD = professional development.

Measures

The questionnaire included several instruments to capture attitudes and beliefs toward teaching science, teachers' self-efficacy toward teaching science, and science-related teaching methods, science-related materials, and the frequency of science-related activities provided to children in the classroom.

Attitudes and Beliefs Toward Teaching Science

The Preschool Teachers' Attitudes and Beliefs Toward Science Teaching questionnaire (PTABS; Maier et al., 2013) was developed in an effort to improve on previous and limited measurements on ECE teachers attitudes and beliefs toward teaching science (see Cho et al., 2003; Coulson, 1992) by providing a valid and reliable measure using teacher-reported science activities, participation in activities, and observing classroom practices (Maier et al., 2013). The PTABS, a 35-item inventory with 11 negatively phrased items, uses a 5-point Likert-type scale (1 = *strongly disagree* to 5 = *strongly agree*). Distributed across three factors of Teacher Comfort, Child Benefit, and Teacher Challenges, the items are summed for each subscale. The first factor, Teacher Comfort, included 14 items that measured teachers' comfort of planning and providing science activities, such as "I feel comfortable doing science activities in my early childhood classroom" and "I use the internet to get ideas about science activities for young children"). The 10-item factor, Child Benefit, measured whether teachers' believed science teaching supported children's science interests and school readiness. Examples include "Young children are curious about scientific concepts and phenomena" and "Science related activities help improve preschoolers' language skills." The last factor, Teacher Challenges with seven items, encompassed the discomfort teachers feel regarding their science teaching abilities and time and materials available. Statements included "I do not have enough scientific knowledge to teach science to young children" and "Preparation for science teaching takes more time than other subject areas." Negatively phrased items are reverse coded so that higher scores reflect a teachers' experience of greater and more positive degrees of attitudes and beliefs. For example, after reverse coding, ECE teachers that scored higher on Teacher Challenges indicated less challenges. According to Maier et al. (2013), four additional items did not load on any of the three factors but were included in the original instrument. Those four were not included in the current study's analysis. Maier et al. (2013) reported adequate internal consistency of Teacher Comfort (α = .89), Child Benefit had an alpha of .85 Teacher Challenges had an alpha of .71 (Maier et al., 2013). In the current study, Teacher Comfort, Child Benefit, and Teacher Challenges, demonstrated adequate internal consistency (α =.84; α = .83; α =.79, respectively). Maier et al. (2013) reported the overall internal consistency as high (Cronbach's α = .91). The current study calculated α =.88 for overall internal consistency.

Self-Efficacy Beliefs About Teaching Science

The Teacher's Science Teaching Efficacy Belief Instrument (STEBI; Riggs & Enochs, 1990) was developed for primary and secondary in-service teachers. The instrument was formulated on the basis that teacher efficacy is situation-specific and teachers may have higher efficacy depending on the subject being taught—the subject for this instrument being science. Drawing on Bandura's (1977) social learning theory and research on self-efficacy and Gibson and Dembo's (1984) teacher efficacy construct, the STEBI divides two dimensions of self-efficacy when teaching science rather than one combined measurement—the teachers' belief in their own ability to teach (Personal Science Teaching Efficacy Belief [PSTE]; α = .92) and their students' ability to learn (Science Teaching Outcome Expectancy [STOE]; α = .77). The current study used 22 of the 25-item, excluding the original items 4, 7, and 12 because of their incompatibility to the ECE environment. Some items that were used were modified to accommodate the uniqueness of the ECE environment by using "children" instead of "students." The PSTE dimension includes items such as "I know the steps necessary to teach science concepts effectively" and "I am continually finding better ways to teach science." The STOE dimension includes items such as "The low science achievement of some students [children] cannot generally be blamed on their teachers" and "Effectiveness in science teaching has little influence on the achievement of students [children] with low motivation." The 5-point Likert-type scale format ranges from 1(*strongly disagree*) to 5(*strongly agree*). For the current study, internal consistency for PTSE (12 items) and STOE (10 items) was .87 and .66, respectively.

Frequency of Teachers' Science-Related Teaching Methods

To capture a reflection of classroom practices, the researcher used the teachers' version to the Trends in International Mathematics and Science Study (TIMSS; International Association for the Evaluation of Educational Achievement [IEA], 2017), an assessment that measures trends of students from around the world regarding math and science knowledge. To measure the prevalence of ECE teachers' science-teaching behaviors, 11 items from TIMSS question 27 asked how often the teacher used science-related teaching methods. Items include "I ask children to listen to me explain new science content" and "I ask the children to watch me demonstrate an experiment or investigation" (see IEA, 2017, p.17). The items were adapted from the original 4-point scale (*Every or almost every lesson*; *about half the lessons*; *some lessons*; and *never)* to a 5-point scale (5 = *Every or almost every lesson/activity*; 4 = *about half the lessons/activities*; 3 = *some lessons/activities*; 2 = *a few lessons/activities*; and 1 = *rarely or never*) to measure frequency. Some items were adapted to accommodate the developmental appropriateness of the ECE setting. For example, the item asking how often the teacher asks the students to "read their textbooks or other resource materials" was changed to how often the teacher would "read aloud children's books or other resource materials related to science." The overall internal consistency was excellent (Cronbach's α = 92).

Provision of Science-Related Materials

Items were adapted to breakdown elements of the learning environment provided in the NAEYC Early Standards (2017; 2019) and Nevada PreK Standards for Science Introduction (Nevada State Board of Education, 2010). Two items on a 5-point scale (*none*; *a few [1-2 items]*; *some [3-5 items]*; *several [6-9 items]*; and *many [10 or more items]*) were based on the estimated provision of toys or materials: "Are there toys or materials which encourage children to see, touch, hear, and when appropriate, taste and smell in your classroom? (One sensory set can be 1 item)" and "Are there toys or materials which encourage children to solve simple problems to learn cause-and-effect relationships? (e.g., rolling toy cars down a ramp; ice on the sidewalk on a warm day)" (see NAEYC, 2017, p. 21). The overall internal consistency was α = .78.

Science-Related Activities

To encapsulate question 26b of TIMSS, "Please estimate the time that you spend on science topics with students in this class" (IEA, 2017, p. 13), questions adapted from the NAEYC Early Learning Program Standards (2017) and the Nevada PreK Standards for Science Introduction (2010) were formulated to assess the frequency of science activities of science concepts (i.e., Nature of Science, 9 items; Life Science, 8 items; Physical Science, 7 items; and Earth Science, 6 items). Nature of Science items also incorporated details from the NAEYC Early Standards (2017). One score was averaged from the 30 items and rated on a 5-point scale (1 = *I have not done this yet*, 2 = *a few times a year*, 3 = *a few times a month*, 4 = *a few times a week*, and 5 = *a few times a day*). The current study calculated the internal consistency as high (Cronbach's α = .97).

Program Type

The variable of program type was determined by an item that asked participants in what type of program they were employed. Private programs were faith-based child care centers or private child care centers and coded as 0. Public programs are federally, state, or similarly funded programs including Early Head Start, Head Start, State-funded PreK, University laboratory school and coded as 1.

Neighborhood Income Level

The survey item, "What is your early care and education program zip code?" was used to determine program location. The factors considered for low neighborhood income levels were 1) median family income according to the zip code of the program; 2) the percentage of children qualifying for free and reduced lunches (FRL) in the community was above 50%; 3) percentage of Title 1 schools in the community was above 50%; 4) the percentage of families in poverty in the community was above 11.8%.

Low median family income is defined by a family earning less than 200% of federal poverty level income (National Center for Children in Poverty, 2018). The U.S. federal poverty threshold in 2020 for a four-person household was $26,200 (U.S. Department of Human and Health Services, 2020). Thus, for a family of four with two children, low-income would equate to earning less than $52,400 a year. This amount corresponds closely to the Pew Research Center's (Bennett et al., 2020) income calculator created with 2018 government data. In adjusting for location and cost of living, the calculator computes that a four-person family in the sample metropolitan area with an income less than $55,058 is considered low income.

Two online data information sites that collect information by zip codes (i.e., Income By Zip and Zipdatamaps) verified median family income per the zip code as well as demographic information regarding schools. Schools with high concentrations of student poverty qualify for financial assistance under Title 1 of the Elementary and Secondary Education Act. Schools can implement Title 1 programming if 40% of enrolled students are from low-income families (Snyder et al., 2018). Many schools distribute Title 1 funds depending on the overall data of student eligibility of FRL (Snyder et al., 2018). According to the NCES (2020), mid-high poverty schools refer to those with 50.1% to 75.0% of eligible students for FRL while high-poverty schools refer to those with above 75% students eligible for FRL. The percentage cap for the criteria (11.8%) is based on the U.S. poverty rate for 2018 (Semega et al., 2020). To be considered a low-income neighborhood for this study, programs were not public-based (e.g., state-funded, university laboratory schools, Head Start, etc.) and communities had to hold at least three of four criteria.

Data Analysis Plan

Data were exported from the online survey to be analyzed via IBM SPSS Statistics Version 26. Descriptive statistics were used to summarize the attitudes and beliefs towards science teaching (i.e., PTABS subscales; STEBI subscales) and science-related classroom practices (i.e., science-related teaching methods, science-related materials, and science-related activities), including means, standard deviations, minimums, maximums, skewness, and kurtosis. Means and standard deviations were used for teachers' age, teachers' experience in the field, time in the current program, and teachers' wage. Frequencies were used to describe the distribution of teachers' age, gender, ethnicity, educational attainment, science-related professional development, teachers' experience in the field, teachers' employment hours, program type, and neighborhood income. Pearson's correlation was conducted to examine the relationships between teachers' professional characteristics (i.e., age, education level, science-related professional development, wage, and experience in the field), program characteristics (i.e., program type, neighborhood income level), attitudes and beliefs towards science teaching, and science-related classroom practices. An independent samples *t*-tests was conducted to determine whether there were differences between ECE teachers with or without a bachelor's degree on attitudes and beliefs toward science teaching and classroom practices. An α level of .05 was preselected as an acceptable level of statistical significance.

Chapter Four: Results

Preliminary Analysis

Descriptive statistics for attitudes and beliefs toward science teaching variables are presented in Table 2. Descriptive statistics for science-related classroom practices items are presented in Appendix B. The statistics of skewness and kurtosis demonstrate normal distribution of the study variables.

Table 2

Descriptive Statistics for Attitudes and Beliefs Towards Science Teaching

Variable	*M*	*SD*	Min	Max	Skew	Kurtosis
Attitudes and Beliefs Towards Science Teaching						
Child benefit	4.62	0.43	3.10	5.00	-1.19	1.11
Teacher comfort	4.07	0.52	2.50	4.71	-0.92	0.37
Teacher challenges	3.31	0.88	1.00	5.00	-0.20	-0.43
Science Teaching Efficacy Beliefs						
PSTE	3.71	0.66	2.33	5.00	-0.05	-0.68
STOE	3.51	0.48	2.50	4.80	0.49	0.31

Note. N = 110.
PSTE = Personal science teaching efficacy belief; STOE = Science teaching outcome expectancy.

Attitudes and Beliefs and Classroom Practices

As presented in Table 3, relationships between teachers' attitudes and beliefs toward science teaching (i.e., Child Benefit, Teacher Comfort, and Teacher Challenges) were associated with their classroom practices, indicating that greater ECE teachers' attitudes and beliefs towards teaching science, the more likely ECE teachers used science-related teaching methods, provided more science-related materials, and provided more science activities in their classrooms. The PSTE subscale from the science teaching efficacy beliefs was also positively linked to classroom practices. Similarly, the STOE subscale had a positive relationship with classroom practices in terms of using science-related teaching methods and the provision of science-related materials in the classroom. However, there was no statistically significant correlation between the STOE subscale and the frequency of providing science-related activities classroom.

Table 3

Intercorrelations for Attitudes and Beliefs and Classroom Practices

	Classroom Practices		
Attitudes and Beliefs	Science - related materials	Science-related teaching methods	Science-related activities
Attitudes and beliefs towards science teaching			
Child benefit	.283**	.194*	.229*
Teacher comfort	.386***	.588***	.415***
Teacher challenges	.348***	.265**	.283**
Science teaching efficacy beliefs			
PSTE	.388***	.451***	.399***
STOE	.232**	.194*	.086

Note. PSTE = Personal science teaching efficacy belief; STOE = Science teaching outcome expectancy.
**p* < .05. ***p* < .01. ****p* < .001.

Professional Characteristics, Attitudes and Beliefs, and Classroom Practices

The second question in the present study examined relationships between ECE teachers' professional characteristics (i.e., education level, science-specific professional development, wage, and years of experience in the field,), their attitudes and beliefs towards teaching science to young children, and their classroom practices. Table 4 presents the correlations between ECE teacher professional characteristics and attitudes and beliefs toward science teaching.

Table 4

Intercorrelations for Attitudes and Beliefs and Professional Characteristics

	Professional Characteristics			
Attitudes and Beliefs	Education[a]	SPD	Wage	Experience
Attitudes and Beliefs Towards Science Teaching				
Child benefit	.276**	.216*	.216*	.268**
Teacher comfort	.250**	.220*	.066	.257**
Teacher challenges	.299**	.156	.187+	.290**
Science Teaching Efficacy Beliefs				
PSTE	.282**	.204*	.133	.184+
STOE	.172+	.205*	.165+	.118

Note. PSTE = Personal science teaching efficacy belief; STOE = Science teaching outcome expectancy; SPD = Science-related professional development, 0 = no, 1 = yes.

[a] Education was on the six levels. See Table 1.

+p < .10. *p < .05. **p < .01.

Results demonstrated that ECE teachers with higher educational attainment reported more favorable attitudes and beliefs except for the STOE belief where there was no relationship. ECE teachers with more years in the field were likely to have reported greater levels of attitudes and beliefs towards science teaching (i.e., Child Benefit, Teacher Comfort, and Teacher Challenges). Years in the field did not have a statistically significant relationship between PSTE nor STOE. Teachers' wage was positively related to Child Benefit. Moreover, teachers that participated in science-related professional development were more likely to score higher on all attitude and beliefs subscales except for Teacher Challenges.

Table 5 presents relationships between ECE teachers' professional characteristics and actual classroom practices. ECE teachers' level of educational attainment was significantly and positively linked to science-related materials, methods, and frequency of activities. ECE teachers who participated in science-related professional development also reported more science-related materials, more science-related teaching methods. and more frequent science activities. ECE teachers' wage was positively correlated with science-related materials in the classroom. Greater years of experience in the ECE field was related to more science-related materials and more frequent science-related activities.

Table 5

Intercorrelations for Classroom Practices and Professional Characteristics

	Professional Characteristics			
Classroom Practices	Education[a]	SPD	Wage	Experience
Science-related materials	.189*	.247**	.202*	.320**
Science-teaching methods	.306**	.305**	.084	.191+
Science-related activities	.304**	.253**	.140	.215**

Note. SPD = Science-related professional development, 0 = no, 1= yes.
[a] = Education was based on the six levels. See Table 1.
$+p < .10$. $*p < .05$. $**p < .01$.

Table 6 presents results for an independent *t*-test to compare attitudes and beliefs for ECE teachers by education level which was dichotomized to teachers with or without a bachelors' degree. For Child Benefit, scores for ECE teachers with a bachelor's degree (M = 4.72, SD = 0.37) were higher than ECE teachers without a bachelor's degree (M = 4.53, SD = 0.46), t(107.81) = 2.36, p =.020, d = .46). Levene's Test for Equality of Variances indicated unequal variances (F = 5.25, p = .024), so degrees of freedom were adjusted from 110 to 107.81. The test for Teacher Comfort did not reach statistical significance. The results from the Teacher Challenges (after being reverse scored) were found to be statistically significant, t(108) = 3.35, p = .001, d = .64. The findings indicate that ECE teachers with a bachelor's degree (M = 3.61, SD = 0.80) perceived less challenges with teaching science than those without a bachelor's degree (M = 3.07, SD = 0.88). When comparing scores for Teaching Efficacy, the test reached statistical significance, t(108) = 3.09, p = .003, d = .63. The result indicated that ECE teachers with a bachelor's degree (M = 3.91, SD = 0.63) reported greater science-teaching efficacy than those without a bachelor's degree (M = 3.54, SD = 0.63). The test for Outcome Expectancy was not statistically significant.

Table 6 also shows results from an independent samples *t*-test comparing science-related classroom practices for ECE teachers with or without a bachelor's degree. The test results showed that ECE teachers with a bachelor's degree (M = 3.83, SD = 0.99) reported more science-related materials than ECE teachers without a bachelor's degree (M = 3.46, SD = 0.89) , t(108) = 2.08, p = .040, d = .40. The results indicate that ECE teachers with a bachelor's degree (M = 3.53, SD = 0.83) used significantly more science-related teaching methods than those without a bachelor's degree (M = 3.03, SD = 0.94),

$t(108) = 2.93$, $p = .004$, $d = .64$. For Science Activities, the test reached statistical significance, $t(108) = -3.34$, $p = .001$, $d = .64$. The findings demonstrate that ECE teachers with a bachelor's degree ($M = 3.46$, $SD = 0.81$) reported more science-related activities than those without a bachelor's degree ($M = 2.95$, $SD = 0.80$).

Table 6

Differences Between Educational Attainment

	No Bachelor's[a]		Bachelor's[b]				
Variable	*M*	*SD*	*M*	*SD*	*df*	*t*	Cohen's *d*
Preschool Teachers' Attitudes and Beliefs							
Child Benefit	4.53	0.46	4.72	0.37	107.81	2.36*	.46
Teacher Comfort	3.99	0.57	4.17	0.45	108	1.82+	.35
Teacher Challenges	3.07	0.88	3.61	0.80	108	3.35**	.64
Science Teaching Efficacy Beliefs							
PSTE	3.54	0.63	3.91	0.63	108	3.09**	.59
STOE	3.44	0.42	3.58	0.54	108	1.59	.30
Science-related Classroom Practices							
Materials	3.46	0.89	3.83	0.99	108	2.08*	.40
Teaching Methods	3.03	0.94	3.53	0.83	108	2.93**	.56
Activities	2.95	0.80	3.46	0.81	108	3.34**	.64

Note. PSTE = Personal science teaching efficacy belief; STOE = Science teaching outcome expectancy.
[a]$n = 60$. [b]$n = 50$.
+$p < .10$. *$p < .05$. **$p < .01$.

Program Characteristics, Attitudes and Beliefs, and Classroom Practices

The third question of the current study examined relationships between ECE teachers' attitudes and beliefs toward teaching science and their classroom practices according to their program characteristics. As presented in Table 7, there was no relationships between attitudes and beliefs and program type. Additionally, there was no correlation between neighborhood incomes and attitudes and beliefs toward teaching science.

Table 7

Intercorrelations for Attitudes and Beliefs and Program Characteristics

Attitudes and Beliefs	Program Characteristics	
	Program type[a]	Neighborhood income
Attitudes and Beliefs Towards Science Teaching		
Child benefit	-.166+	-.145
Teacher comfort	-.085	-.027
Teacher challenges	-.158+	.017
Science Teaching Efficacy Beliefs		
PSTE	-.144	.097
STOE	-.063	.066

Note. [a] Coded "Public program", 0 and "Not a public program", 1.
**p* < .05. ***p* < .01. ****p* < .001.

Table 8 shows results between classroom practices and program characteristics. Results demonstrated a negative correlation between program type and classroom practices, indicating teachers in public programs provided more science-related materials, more science-teaching methods, and more frequent science-related activities. There was no significant links between neighborhood income and science-related classroom practices.

Table 8

Intercorrelations for Classroom Practices and Program Characteristics

Classroom Practices	Program Characteristics: Program type[a]	Program Characteristics: Neighborhood income
Science-related materials	-.274**	.067
Science-teaching methods	-.248**	-.006
Science-related activities	-.351***	.063

Note. [a] Coded "Public program", 0 and "Not a public program", 1.
*p < .05. **p < .01. ***p < .001.

Chapter Five: Discussion and Conclusions

The current study aimed to examine relationships between ECE teachers' attitudes and beliefs toward science and their science-related classroom practices and the links to ECE teachers professional and program characteristics. The current study collected data from 110 lead and co-lead ECE teachers. Participants were recruited from diverse programs (i.e., private, faith-based, Head Start, etc.) which augmented understanding of elements available in different early learning environments (i.e., science teaching methods, materials, and activities). The results from the current study are important in understanding ECE attitudes and beliefs toward teaching science to young children and science-related classroom practices and contributes to the literature on early science learning as it examined relationships in context of ECE teachers' professional and program characteristics. The study's findings indicate that ECE teachers' attitudes and beliefs toward teaching science are linked to their science-related classroom practices. Additionally, ECE teachers' professional characteristics, such as those with a bachelor's degree and those with science-related professional development reported more favorable attitudes and beliefs and more science-related classroom practices.

Attitudes and Beliefs and Classroom Practices

The results indicated that ECE teachers with more favorable attitudes and beliefs toward teaching science were more likely to report greater science-related classroom practices. ECE teachers have often expressed that they believe science learning should begin early because children possess the ability to engage in science activities, and early learning influences children's positive attitudes (Spektor-Levy et al., 2013). Results from this study corresponded with extant research findings that ECE teachers' beliefs about the benefits of children's science learning are linked to their classroom practices, the degree of importance they placed on science teaching, and their enjoyment in engaging in STEM activities (Maier et al., 2013; Spektor-Levy et al., 2013). However, Park et al. (2017) found that teachers who believed STEM was important for young children still often lacked proper training and resources to teach young children, which may be linked to their discomfort in teaching.

The current findings suggest that ECE teachers who report greater levels of comfort in science teaching were more likely to report more science-related classroom practices. The findings are consistent with other studies. Pre-service teachers in Lippard et al. (2018) with higher comfort levels in teaching science reported greater confidence in planning science activities and used inquiry-based approaches in their teaching methods. Maier et al. (2013) also confirmed that increased comfort levels in teaching science was related to an increase actual implementation of science-related classroom practices (Maier et al., 2013). For example, ECE teachers who neglected doing science activities often reported feeling uncomfortable in planning and teaching science (Koballa & Crawley, 1985; Lippard et al., 2018; Spektor-Levy et al., 2013). Accordingly, the current study results indicated that teachers who perceived fewer challenges in teaching science were likely to implement more science-related classroom practices. The opposite holds true as well in that teachers who encounter more challenges emerging from insufficient science knowledge and lack of time may avoid science teaching and activities (Maier et al., 2013; Thulin & Redfors, 2017).

Results also demonstrated ECE teachers with greater science teaching self-efficacy reported more science-related teaching methods, more science-related materials, and more time dedicated to implementing science activities. Interestingly, scores on outcome expectancy were not related to the frequency of science activities. De Laat and Watters (1995) found that some teachers believed that they were good at teaching in general but not science. Moreover, they believed children benefit from effective, quality science teaching; yet, those beliefs did not equate into implementing science teaching (de Laat & Watters, 1995). De Laat and Watters (1995) findings countered those of Aydoğdu and Peker's (2016) that both teaching self-efficacy and outcome expectancy were linked to teachers providing more time to science activities. They suggested that more time teachers place on providing science-related activities might relate to higher competencies in science and therefore greater self-efficacy and outcome expectancies when teaching science (Aydoğdu & Peker, 2016). The null findings between outcome expectancy and science-related activities in the present study may be a result from underlying issues such as memory recall, social desirability effect, or fear of reprisal common when using self-report surveys. Moreover, ECE teachers may have different experiences and expectations in terms of the teaching they can provide and learning that young children can achieve in comparison to teachers of older children.

Professional Characteristics, Attitudes and Beliefs, and Classroom Practices

Several relationships emerged when examining ECE teachers' professional characteristics, their attitudes and beliefs towards teaching science, and their science-related classroom practices. ECE teachers in the current study with higher educational attainment reported favorable attitudes and beliefs except outcome expectancy. Gerde et al. (2018) reported that higher educational attainment in the ECE field related to ECE teachers' greater degrees of self-efficacy. The variability in responses for outcome expectancy may have to do self-report issues, but it may also have to do with the teachers' educational major (Kolbe & Jorgensen, 2018) or preparedness for teaching science. Teachers have reported having high teaching efficacy overall but not for science teaching (de Laat & Watters, 1995). Many ECE programs in the U.S. do not require that teachers attain higher education; moreover, those teachers that have educational requisites often have few science-related courses during pre-service training. Thus, more science-related courses may be beneficial to improve ECE teachers' comfort and self-efficacy in science. The present study further found that ECE teachers with higher educational attainment reported more science-related classroom practices. Likewise, studies have similarly found that higher educational attainment was related to greater degrees of science instructional support, science-related opportunities and activities, and more science-related toys and materials in the classroom (Gerde et al., 2018).

ECE teachers in the current study who participated in science-related professional development scored higher on most attitudes and beliefs, except for teacher challenges. Pendergast et al. (2017) discovered similar findings in that prekindergarten teachers with science-related professional development did not differ on teacher challenges in comparison with teachers that did not have science-related professional development. The participation of professional development may compound some challenges such as time management while ameliorating other challenges, such as discomfort in teaching science. Indeed, teachers that had science-related professional development were more comfortable planning and doing science and acknowledged science-related activities enhanced young children's math and social skills (Pendergast et al., 2017). Other studies confirm these findings that teachers with science-related professional training reported greater comfort and confidence in planning and teaching science concepts to young children (Aldemir & Kermani, 2017; Pendergast et al., 2017; Thulins & Redfors, 2017). Thus, science-related professional development may be important in improving ECE teachers' attitudes and beliefs toward science. Pre-k teachers in Aldemir and Kermani (2017) divulged that they focused more on literacy in their classroom curriculum before they participated in a STEM intervention program. Many of the teachers also revealed that they did not believe some concepts could be taught to young children. After the intervention, they expressed greater confidence and improvement in STEM-related concept knowledge and skills which helped motivate them to teach science and integrate the concepts into their lessons (Aldemir & Kermani, 2017). Other studies concur that education attainment and science-specific professional development has been linked to greater confidence and comfort in planning and doing science (Aldemir & Kermani, 2017; Pendergast et al., 2017). Moreover, they have been associated with teachers using more inquiry-based teaching in their classrooms (Erden & Sönmez, 2011; Gerde et al., 2018; Kolbe & Jorgensen, 2018; Piasta et al., 2014). Finally, teachers with higher educational attainment and those with more science-specific professional development provided more science materials in their classroom environment (Gerde et al., 2018). Clearly, educational attainment and science-related professional development may be crucial in enhancing and augmenting ECE teachers' attitudes and beliefs toward teaching science and increasing science-related classroom practices.

ECE teachers who reported higher wage earnings also held greater beliefs that science learning was beneficial to young children. Whitebook et al. (1989; 2014) reported that higher wages were linked to more responsive and sensitive caregiving as well to higher quality of care. When providing science-related learning, responsive caregiving can be translated as the teachers' attention to children's interest and respectful, open responses to children's science questions (Spektor-Levy et al., (2013). The variability in the remaining attitudes and beliefs may be due to other factors. The current study also found that teachers' wage was linked to an increase in science-related materials in the classroom. At first glance, this may make sense as the program being able to pay a higher wage may also be able to afford to outfit the classroom environment with more physical resources. However, the other factors of classroom practices may be dependent on the interplay of other professional characteristics and should be examined further.

Interestingly, ECE teachers in the present study who have worked longer in the ECE field reported greater attitudes and beliefs in terms of the benefits of science teaching to young children, their comfort in teaching, and perception of less challenges. This link was not presented for ECE teachers' science teaching efficacy nor outcome expectancy. Other studies had similar findings in which field experience had no significant relationship with science teaching efficacy scores (Aydoğdu & Peker, 2016; Gerde et al., 2018). The current study also found that teachers longer in the ECE field reported greater science-related classroom practices. It may be that over many years of incorporating science curriculum into the schedule and through years of repetitious planning and implementing, providing science activities may become commonplace. Alongside teachers' longevity in the field, other factors may influence teachers incorporating more science practices. The current study, to the researchers' knowledge, is the first to examine relationships between ECE teachers' years of experience in the field and their science-related classroom practices.

Program Characteristics, Attitudes and Beliefs, and Classroom Practices

The present study provided a broader range of ECE teachers in private and public programs in comparison to other studies that only focused on public programs (Gerde et al., 2018; Maier et al., 2013; Tu, 2006). Not all programs are equal and provide the same instructional time and resources (Wrigley, 1989) especially in terms of science-related opportunities (Gerde et al., 2018; Greenfield et al., 2009; Tu, 2006). Teachers from public programs in the current study reported greater frequency of science-related teaching methods, provided more science-related activities, and more science materials than those in private programs. One may argue that the evaluative nature of performance standards in public programs and their greater staffing qualifications (HSPS, 2016) may put demands on the teachers to adhere to higher standards (Gerde et al., 2018). Private programs under their own volition may have very different standards and requirements in terms of structural and process quality (Coley et al., 2016).

The current study found no correlations between attitudes and beliefs toward science, classroom practice, and neighborhood incomes. However, previous research has found that teachers in schools in low-income neighborhoods provided less emotional support (Bassok & Galdo, 2016) and emphasized basic skills and knowledge acquisition as primary ECE goals for school readiness (Stipek & Byler, 1997). The participants in the current study came from an array of program types from low and not low-income neighborhoods. While public programs may be located in either low- or not low-income neighborhoods, the specific program will still have the same standards and requirements despite their location (HSPS, 2016). For example, a Head Start program in a low-income neighborhood would retain the same requisites and standards in a not low-income neighborhood. It may be that private programs differ between low- and not low-income neighborhoods whereas the public programs hold to their same standards for each program type. Future investigation should assess interaction effects of the differences depending on ECE teachers in private or public programs and low- or not low-income neighborhoods.

Limitations and Future Directions

The current study has potential limitations. Participants were not randomly selected for the study which contributed to selection bias. Future studies should concentrate on random sampling and recruiting a more diverse sample. The current study being correlational cannot be interpreted as causation. The data also relies on self-report, which may be subject to issues, including social desirability effects, troubles with accurate memory recall on practices, and fear of reprisal from program directors. To avoid a social desirability effect and fear of reprisal, during the recruitment procedure, ECE teachers were fully and repeatedly informed that their information was confidential and anonymous, and their responses would only be shared among the researchers. Still, self-report should be considered with caution. Future studies could integrate direct classroom observations over multiple time periods in the school year to help establish a clear illustration of ECE teachers' science-related classroom materials, their engagement in science teaching and activities. Moreover, including open-ended questions or personal interviews and focus groups with survey data may help to generate a richer and deeper understanding of factors that influence ECE teachers' attitudes and beliefs toward science and classroom practices, such as personal experiences.

Lastly, there may have been issues with the science teaching efficacy scale as it was originally developed for elementary school teachers. Riggs and Enochs (1990) suggested that items within the outcome expectancy subscale may have issues with predictability because of factors that may be experienced and interpreted in different ways by teachers. These experiences may also translate differently to ECE teachers who have unique needs and experiences when providing science learning. ECE teacher experiences may include inadequate science training, managing young children's limited ability to focus for long durations, and integrating readiness domains in a condensed, compartmentalized schedule (Greenfield et al., 2009). So, although in the current study the instrument was modified and items were omitted to accommodate for the ECE teacher environment, it may be a science teaching efficacy measurement should be developed that captures the ECE teacher experience, the program climate, and the ECE environment in relation to teaching science.

Implications

Beyond these limitations, the findings have implications for fostering ECE teachers' attitudes and beliefs toward science and supporting their science-related classroom practices. The current study's findings in terms of teachers' professional characteristics warrants deeper examination of their interplay with attitudes and beliefs towards teaching science and science-related classroom practices. Future studies need to investigate the moderation effects between ECE teachers' wages, years of experience, educational attainment, professional development, and attitudes and beliefs.

Furthermore, educational attainment and science-related professional development are important factors that related to attitudes and beliefs and classroom practices. Thus, ECE teachers would benefit from science-related coursework and training while pursuing a college degree. Likewise, it is imperative that program directors provide the opportunity for sustainable science-related professional development. ECE teachers who are afforded opportunities to learn and understand science concepts and how to plan and teach science to young children may also increase their confidence and competence in teaching (Greenfield et al., 2009). Thus, providing teachers with sufficient and sustainable training may help in bolstering their science-teaching self-efficacy and their attitudes toward children's benefits and outcomes. In order to provide science-related activities, teachers should be provided ample and appropriate science-related professional development opportunities which include methods of implementation. ECE teachers need science-related interventions (see French, 2004; Zack et al., 2017) that are tailored to the unique needs of ECE teachers and that equip teachers with the science-specific content knowledge and skills needed to effectively engage with young children.

ECE pre-service teachers have been observed avoiding and not engaging children in the science center (Lippard et al., 2018). Thus, ECE teachers may need other alternatives to be motivated and encouraged to teach science. Program directors and pre- and in-service teacher trainers should emphasize science learning by providing science-teaching methods and activities. Course instructors and program directors could perhaps highlight that science for young children need not be rife with complex topics, but rather they can emphasize the use of simple everyday inquiry like making observations, predictions, and collecting information–science behaviors that children are already innately good at doing (French, 2004).

High quality science-learning is crucial for young children. However, as Pianta et al. (2016) argue, high quality is not always accessible especially for low-income children. Yet, children's experiences can be improved when teachers are provided subject-specific and sustainable professional development (Pianta et al., 2016). Thus, in order to improve science-learning quality in ECE, the current findings have further implications for policy to impose national science-learning standards that should be implemented in programs as requirements rather than guidelines.

Moreover, ECE teachers are facilitators of young children's learning and school readiness. ECE teachers' attitudes and beliefs toward science teaching is important in predicting their classroom practices. However, the ECE field is often depreciated even when teachers have attained higher education (Whitebook et al., 1989; 2014). ECE teachers are still underpaid and receive less benefits than those in the public education system and even less than other civilian employment with higher education requisites. Lower wages are less likely to attract highly qualified teachers who understand child development and foster quality interactions in the classroom. Hence, researchers and policymakers should continue to advocate and make effort to increase ECE teachers' wages and improve benefits (Whitebook et al., 1989; 2014).

Conclusions

Early science education is receiving growing attention due to its importance for children's school readiness and economic benefit. The current study's findings add to the growing body of literature that promotes awareness of the importance of supporting teachers through wage increases, science-related educational and professional development opportunities (Whitebook et al., 1989; 2014). It is important for young children to have teachers who are highly confident and comfortable in their science teaching and believe that children benefit from early science learning. ECE teachers are the primary facilitators of science learning for young children and need support in providing effective science teaching. Similarly, science-related classroom practices could use a boost to provide young children with quality science-related learning. As Spektor-Levy et al. (2013) argued, policymakers must not assume that ECE teachers possess an innate tendency to be creative and resourceful or hold a multidisciplinary perspective. Science-related professional development provides science-related knowledge, tools, and skills that may be integrated into all curricula subjects especially in circumstances when ECE schedules are full of other activities. Teachers need ample science-related professional development opportunities to improve science-teaching efficacy and attitudes towards science and to enhance science-related classroom practices that support young children's science learning.

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Appendix A: IRB Approval

University of Nevada, Reno

Research Integrity Office
218 Ross Hall / 331,
Reno, Nevada 89557
775.327.2368 / 775.327.2369 fax
www.unr.edu/research-integrity

DATE:	March 1, 2018
TO:	Hyun-joo Jeon, Ph.D.
FROM:	University of Nevada, Reno Institutional Review Board (IRB)
PROJECT TITLE:	[1134494-1] Early Care and Education (ECE) Teachers' and Parents' Beliefs About Science
REFERENCE #:	Social Behavioral
SUBMISSION TYPE:	New Project
ACTION:	DETERMINATION OF EXEMPT STATUS
DECISION DATE:	March 1, 2018
REVIEW CATEGORY:	Exemption Category-*Flex Policy*

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The Research Integrity Office, or the IRB reviewed this project and has determined it is EXEMPT FROM IRB REVIEW according to federal regulations. Please note, the federal government has identified certain categories of research involving human subjects that qualify for exemption from federal regulations.

Only the Research Integrity Office and the IRB have been given authority by the University to make a determination that a study is exempt from federal regulations. The above-referenced protocol was reviewed and the research deemed eligible to proceed in accordance with the requirements of the Code of Federal Regulations on the Protection of Human Subjects (45 CFR 46.101 paragraph [b]).

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Reviewed Documents

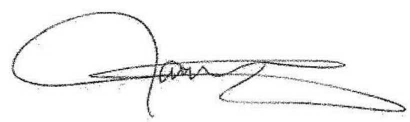
- Advertisement - Teacher Flyer recruitment for Science 2018-02-26-VR-HJ.pdf (UPDATED: 02/26/2018)
- Advertisement - Parent Flyer for Science 2018-02-26-VR-HJ.pdf (UPDATED: 02/26/2018)
- Advertisement - SB Recruitment Phone Script-2018-02-26-VR-HJ.docx (UPDATED: 02/26/2018)
- Advertisement - Recruitment Email Script- 2018-02-26-VR-HJ.docx (UPDATED: 02/26/2018)
- Application Form - Exempt 2 Tests Surveys Interviews Observation 031017-2018-02-26f.docx (UPDATED: 02/26/2018)
- Application Form - 1_Part II Application SOC-ED 033116-Jeon-2018-02-26_f.docx (UPDATED: 02/26/2018)
- Consent Form - SB Study Consent Form for Teacher_f.docx (UPDATED: 02/26/2018)
- Consent Form - SB Study Consent Form for Parent_f.docx (UPDATED: 02/26/2018)
- Questionnaire/Survey - Parent Sicence Activity-2018-02-26.docx (UPDATED: 02/26/2018)
- Questionnaire/Survey - Teacher Basic Information-2018-02-26.docx (UPDATED: 02/26/2018)
- Questionnaire/Survey - Preschool Parent Attitudes & Beliefs toward Science Questionnaire-2018-02-26.docx (UPDATED: 02/26/2018)
- Questionnaire/Survey - Parent Basic Information-2018-02-26.docx (UPDATED: 02/26/2018)
- Questionnaire/Survey - Preschool Teacher Attitudes and Beliefs toward Science Questionnaire.docx (UPDATED: 02/26/2018)

- Training/Certification - citiCompletionReport-Sara Johnson.pdf (UPDATED: 02/26/2018)
- Training/Certification - CITI_Report_Nina Jahnes-2016-05-02.pdf (UPDATED: 02/26/2018)
- Training/Certification - CITI training Lewis Kolbie-2017-08-28.pdf (UPDATED:02/26/2018)
- Training/Certification - 01 Jeon CITI training 2013-09-27.pdf (UPDATED: 02/26/2018)
- Training/Certification - CITI training Victor Richard-2015-12-25.pdf (UPDATED:02/26/2018)
- University of Nevada, Reno - Part I, Cover Sheet - University of Nevada, Reno - Part I, Cover Sheet (UPDATED: 02/28/2018)

If you have any questions, please contact Nancy Moody at 775.327.2367 or at nmoody@unr.edu.

NOTE for VA Researchers: You are not approved to begin this research until you receive an approval letter from the VASNHCS Associate Chief of Staff for Research stating that your research has been approved by the Research and Development Committee.

Sincerely,



Richard Bjur, PhD
Co-Chair, UNR IRB
University of Nevada Reno

Janet Usinger, PhD
Co-Chair, UNR IRB
University of Nevada Reno

This letter has been electronically signed in accordance with all applicable regulations, and a copy is retained within University of Nevada, Reno IRB's record.

Appendix B: Descriptive Statistics for Classroom Practices

Classroom Practices	*n*	%	*M*	*SD*	Min	Max	Skew	Kurtosis
Science-related materials	110		3.63	0.95	1.50	5.00	0.23	-0.89
None	1	0.9						
A few (1-2 items)	18	16.4						
Some (3-5 items)	45	40.9						
Several (6-9 items)	22	20.0						
Many (10 or more)	24	21.8						
Science-related teaching methods	110		3.26	0.92	1.45	5.00	-0.09	-0.79
Rarely or never	12	10.9						
A few lessons	31	28.2						
Some lessons	36	32.7						
About half of lessons	27	24.5						
Most lessons	4	3.6						
Science-related activities	110		3.20	0.85	1.00	4.73	-0.46	-0.46
Have not done this yet	8	7.3						
A few times a year	34	30.9						
A few times a month	47	42.7						
A few times a week	21	19.1						

Appendix C: Intercorrelations Matrix

Intercorrelations Between Study Variables

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Edu													
2. SPD	.409***												
3. Wage	.472***	.447***											
4. Exp	.248*	.398***	.426***										
5. NI	-.027	-.025	-.214*	.068									
6. PT	-.457***	-.225*	-.551***	-.130	.225*								
7. CB	.276**	.216*	.216*	.268**	-.145	-.166+							
8. CO	.250**	.220*	.066	.257**	-.027	-.085	.532***						
9. CH	.299**	.156	.187+	.290**	.017	-.158+	.378***	.354***					
10. PSTE	.282**	.204*	.133	.184+	.097	-.144	.395***	.586***	.742***				
11 STOE	.172+	.205*	.165+	.118	.066	-.063	.358***	.253***	.165	.288***			
12. STM	.189*	.247**	.202*	.320**	.067	-.274**	.283**	.386***	.348***	.388***	.232**		
13. STB	.306**	.305**	.084	.191+	-.006	-.248**	.194*	.588***	.265**	.451***	.194*	.365***	
14. SA	.304**	.253**	.140	.215*	.063	-.351***	.229*	.415***	.283**	.399***	.086	.541***	.600***

Note. Edu = Highest level of educational attainment; SPD = Science-related professional development or training; Exp = Years of experience in the ECE field; NI = Neighborhood income (low, 0; not low,1); PT = Program type (not public, 0; public, 1).
CB = Child Benefit; CO = Teacher Comfort; CH = Teacher Challenges from Preschool Teachers' Attitudes and Beliefs Toward Teaching Science scale (Maier et al., 2013); PSTE = Personal Science Teaching Efficacy Belief; STOE = Science Teaching Outcome Expectancy subscale from the Science Teaching Efficacy Beliefs Instrument (Riggs & Enochs, 1990); STM = Science-related toys and materials; STB = Science-related teaching behaviors; SA = Science activities.
+ $p < .10$. *$p < .05$. **$p < .01$. ***$p < .001$.